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The Effect of Physical Activity on Blood Homocysteine Concentration

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A B S T R A C T

Homocysteine is vasotoxin as well as neurotoxin produced from methionine amino acid in methionine catabolic cycle. Homocysteine mediated generation of free radicals result into inflammation within brain tissues and endothelial membrane. Regular physical activity is essential to maintain homeostasis among biochemical, growth factors, activator proteins and cell signaling pathways and possesses a nourishing impact on regulatory mechanism of body. To identify association we selected 100 case and 223 control, estimated Homocysteine concentration and physical activity. The Chi square value is 25.11 ($P<0.0001$) and Homocysteine level was significantly low ($P<0.0001$) in physically active persons 12.19 ± 2.72 µmol/L as compared with inactive 17.27 ± 2.12 µmol/L the t test value was 21.44 (95%CI, 4.61- 5.54). Regular physical activity has found to reduce blood Homocysteine concentration.

Introduction

Cellular metabolism produces several intermediate metabolites; some of them exert toxic effect on vascular system (Heart and arteries) called vasotoxins. The toxic effect of such vasotoxins intermediates restricted by balance between production and utilization within the cell.

But due to increasing age, several environmental and genetic factors, the cellular balance is unregulated in some extant which lead into hyper condition of toxic intermediate. The excess cellular concentration of toxic metabolite drains into blood and initiating its toxic action on endothelium.

Homocysteine is vasotoxin as well as neurotoxin produced from methionine amino acid in methionine catabolic cycle as a product of a large number of transmethylation reactions dependent on S-adenosylo-methionine.

As a free amino acid, it exist in either reduced (homocysteine, a thiol, R-SH) or oxidized (homocystine, a disulphide R-SS-R) forms (Thiol = Sulphure analogue of alcohol).

The redox chemistry of Homocysteine is dominated by its thiol group (SH) which is nucliophiles and readily oxidized. Oxidation of two homocysteine molecules yields the

disulphide, two protons (H+) and two electrons.

$$2RSH = RSSR^{+} 2H^{+} + 2e^{-}$$

These electrons then can react singly or in pairs. When it reacts singly with O_2 form superoxide and in paired form produces peroxide. In the presence of trace metal ion homocysteine form highly reactive oxygen species (ROS) (Eikelboom *et al.,* 1999).

$$RS\text{-}H + Tm^{x+} \Longrightarrow R\text{-}S^{\cdot} + Tm^{(x-1)+}$$

$$RS\text{-}H \Longrightarrow H^{+} + RS^{\cdot} + RS^{\cdot} \Longrightarrow RSSR$$

$$RSSR^{\cdot\cdot} \Longrightarrow RSSR$$

$$O^2 \quad O^{2\cdot}$$

Homocysteine mediated generation of free radicals result into inflammation (Libby *et al.,* 2002) within brain tissues and endothelial membrane. Regular physical activity is essential to maintain homeostasis among biochemicals, growth factors, activator proteins and cell signaling pathways and possesses a nourishing impact on regulatory mechanism of body (Shari *et al.,* 2005). A recent study has found a positive association between telomere length and physical activity, physically active men and women are found more lengthen telomere as compared with sedentary (Andrew and Stephen, 2011).

Materials and Methods

To identify association between physical activities with homocysteine concentration we selected case control study. We recruited medically certified 100 patients with increased Homocysteine concentration as a case and age, sex and ethnicity matched 223 healthy persons from same socioeconomic condition as a control. We collected 5 ml. of blood sample in 0.5 M EDTA tubes from each patient as well as from healthy controls for homocysteine analysis.

The concentration of total blood homocysteine of case and control was analyzed by Diazyme Homocysteine Enzymatic Assay **(**by DIAZYME laboratories, catalogue no. DZ1 12 A-K) is based on a novel assay principle that assesses the co-substrate conversion product (a molecule that is not a substrate of the Hcy conversion enzyme, and does not contain any element from sample Hcy) instead of assessing co-substrate. An auto analyzer was used to measure absorbance at 340 nm with temperature control (37° C). Physical activity was measured according to the centre for disease control (CDC's) recommendations for physical activity to adults. It include 150-300 minutes/week of moderate-intensity aerobic activity or 75 minutes/week of vigorous-intensity, in conjunction with 2 days/week of muscle strengthening activities (working major muscle groups: legs, hips, back, abdomen, chest, shoulders, and arms) (CDC; 2010).

Results and Discussion

The clinical features of case and control are given in table 1. Homocysteine concentration is age and sex related hence to neutralize it the age and sex ratio between case and controls are matched.

The number of physically active persons was significantly higher in Control group 59% as compared with case 33%. The Chi square value was 25.11 ($P<0.0001$) (Table 1) indicated significantly deferent proportion of physically active persons in case and control group. Relative risk for was found 0.29 (95% CI, 0.18- 0.48). The values of Homocysteine concentration between physically active and inactive are given in table 2, the Homocysteine level was significantly low

(P<0.0001) in physically active persons 12.19 ± 2.72 µmol/L as compared with non-active 17.27 ± 2.12 µmol/L the t test value was 21.44 (95%CI, 4.61- 5.54). The mean systolic blood pressure was 80/120 in 210 physically active person and 100/140 in 213 physically inactive persons indicating antihypertensive role of physical activity (Fig. 1).

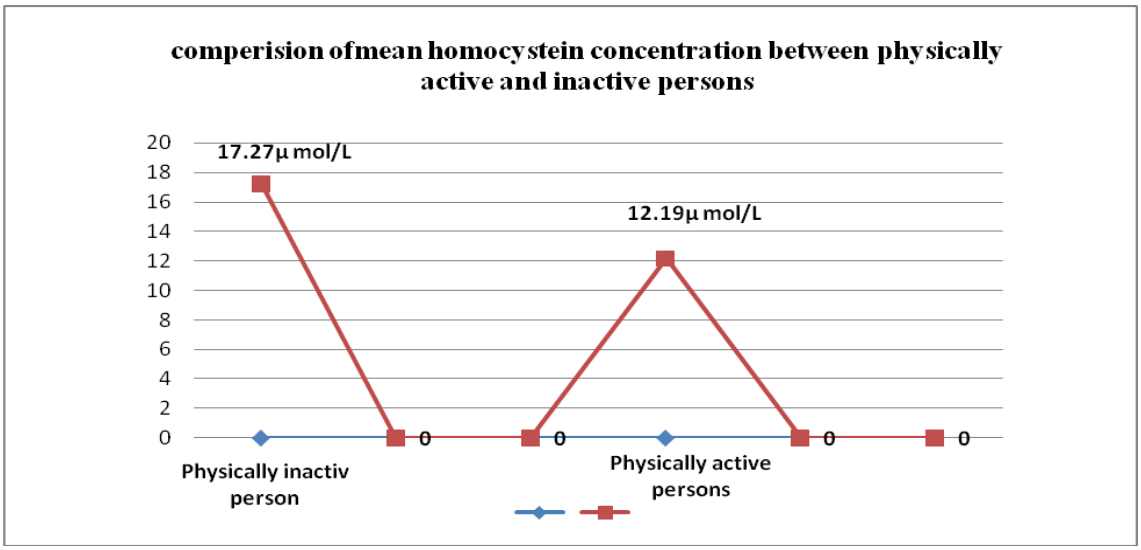
Table.1 Clinical features of case and control

Clinical features	patients	controls
Total number	100	223
Sex (Male: Female)	68:32	138:82
Mean BMI ± SD	24.81 ± 5.39	22.75 ± 4.52
Age (Years)		
Mean ± SD	47.5 ± 5.54	49.79 ± 12.66
Age range	34-56	25-78

Table.2 Comparison of physically active persons between case and control

Factors	Physically inactive person n=100		Physically active person n=223		P Value	OR	95% CI
Number of physically active person (According to CDC; 2010)	n	%	n	%	$\chi 2 = 25.11$ P<0.0001***	0.2955	0.1814 to 0.4811
	33	33	132	59			
Mean Homocysteine (µmol/L) Value ± SD	17.27 ± 2.12		12.19 ± 2.72		t =16.55 P<0.0001***	-	-

Fig.1 Graphical representation of homocysteine concentrations in two experimental groups



Several studies have been successfully established association between elevated homocysteine concentration in blood with increased risk for cardiovascular and neurological diseases (Dwivedi *et al.*, 2011). Homocysteine is a vesotoxin and neurotoxin which initiates as well as accelerate inflammation inside the arteries damaged by raised blood pressure. This inflammation chokes the arteries (Hamer *et al.,* 2009). Physical activity is currently used as an intervention to help reduce the risk of several diseases cardiovascular disease, reduced risk for type 2 Diabetes and metabolic syndrome, reduced risk of some cancers, strengthened bones and muscles, improved mental health, control weight, improved ability to do daily activities, and increase life expectancy (CDC, 2010). The role of physical activity to lowering risk of cardiovascular and neurological disease is remaining unclear. Identification of homocysteine lowering response of physical activity will help to find out the mechanism by which physical activity decreases the risk for disease.

In this study we measured homocysteine concentration of 100 physically inactive persons and 223 physically active persons where the other factors are controlled. Measure of physical activity has been done according the guide line of CDC 2010. By regulating the other factors we find physical activity lowers the homocysteine concentration in blood. The present study found physical activity is an independent life style factor which significantly reduces risk of cardiovascular and neurological disorders by lowering homocysteine. We found 20 minutes/day exercise reduces hypertension within 5 days surprisingly, it were also very helpful to reduce homocysteine level especially aged Hypertensive and all Stroke patients. After controlling other life style and environmental factors we found reduced homocysteine level in physically active persons. A recent Meta-analysis (Silva and Mota, 2014) of different 34 studies demonstrated that regular physical activity is associated with lower homocysteine concentration. Another study from Iran (Alomari *et al., 2016*) and from China (Zhang *et al.,* 2010; Kim *et al.,* 2016) also demonstrated physical activity lowers the blood homocysteine concentration with vitamin supplements but in elders it lowers the homocysteine concentration without vitamin supplements. A European study suggested only trained aerobics lowers the blood homocysteine concentration (James & Earl, 2010; Deminice *et al.,* 2016). A study (Buckner *et al.,* 20016) demonstrated that activities Single and combined associations of accelerometer-assessed physical activity and muscle-strengthening activities associated with low concentration of homocysteine in blood. Woolf *et al.,* (2017) demonstrated that physical exercise increases folate concentration in blood which lowers the homocysteine in blood. Soori *at al.,* (2016) revealed that ten week physical exercise reduces concentration of homocysteine in blood and reduces risk for cardiovascular disease in overweight women. These reports are consistent with our findings that a major role of physical activity in lowering the homocysteine concentration in blood by which it reduces the risk of cardiovascular and neurological disease.

Physical activity lowers the toxins eliminate the risk factors responsible for disease. Physical activity is also found a positive association between telomere length and physical activity, physically active men and women are found more lengthen telomere as compared with sedentary (Andrew and Stephen, 2011). Based on these data we propose that regular physical activity lowers the disease susceptibility by maintaining appropriate concentration of biochemical in the blood.

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